Lower Duwamish Waterway
Slip 4 Early Action Area

Sampling and Analysis Plan for Boundary Definition

Addendum: Pre-Design Investigation Sampling

Submitted to
U.S. Environmental Protection Agency, Region 10
1200 Sixth Avenue
Seattle, WA 98101

Submitted by
City of Seattle
King County

Prepared by
integral consulting inc.

7900 SE 28th Street, Suite 300
Mercer Island, WA 98040

June 8, 2006

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ACRONYMS AND ABBREVIATIONS

ASTM	American Society for Testing and Materials
bgs	below ground surface
bml	below the mudline
CC	subsurface core sample
DGPS	Differential Global Positioning System
DOC	dissolved organic carbon
EAA	early action area
Ecology	Washington Department of Ecology
EE/CA	engineering evaluation/cost analysis
EOF	emergency sewer overflow
EPA	U.S. Environmental Protection Agency
EQuIS	Environmental Quality Information System
FSP	field sampling plan
GIS	geographic information system
HSA	hollow-stem auger
HSP	health and safety plan
LDW	Lower Duwamish Waterway
LDWG	Lower Duwamish Waterway Group
MLLW	mean lower low water
NTCRA	non-time-critical removal action
PCBs	polychlorinated biphenyls
PS	pump station
QA/QC	quality assurance and quality control
QAPP	quality assurance project plan
RCRA	Resource Conservation and Recovery Act
SB	subsurface bank soil composite sample
SC	subsurface core sample
SD	storm drain
SG	surface grab sample
SOP	standard operating procedure
SP	seep water sample
SPT	standard penetration test
SVOCs	semivolatile organic compounds
TCLP	Toxicity Characteristic Leaching Procedure
TSCA	Toxic Substances Control Act
TOC	total organic carbon
TPH-Dx	extended diesel-range total petroleum hydrocarbon
TPH-G	gasoline-range total petroleum hydrocarbon
VOCs	volatile organic compounds

USCS	Unified Soil Classification System
UU	unconsolidated, undrained

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1 INTRODUCTION

The City of Seattle and King County are planning a sediment removal action for cleanup of contaminated sediments in the Slip 4 Early Action Area (EAA) of the Lower Duwamish Waterway (LDW) Superfund Site in Seattle, Washington (Figure 1-1). The goal of the removal action is to significantly reduce the unacceptable risks to the aquatic environment that stem from potential exposure to contaminants in sediments in the slip (Integral 2006). Remediation of Slip 4 will also reduce potential human health risks associated with polychlorinated biphenyls (PCBs) in sediment within the LDW (Integral 2006).

An engineering evaluation/cost analysis (EE/CA) for the Slip 4 removal action was submitted to the U.S. Environmental Protection Agency (EPA) in February 2006 (Integral 2006). The EE/CA presents a proposed removal action boundary, documents the development and evaluation of alternatives for conducting the non-time-critical removal action (NTCRA), and discusses the rationale for the recommended removal action. Following public comment on the EE/CA, EPA, in consultation with the Washington Department of Ecology (Ecology), selected the removal alternative to be implemented by the City and King County (USEPA 2006).

This document is an addendum to the *Lower Duwamish Waterway Slip 4 Early Action Area: Sampling and Analysis Plan for Boundary Definition* (Boundary Definition SAP) (Integral 2004b). This Pre-Design SAP Addendum presents the sampling design and rationale for the collection of data needed to support the design of the removal action alternative (Alternative 2) selected by EPA. Section 2 describes the recommended removal alternative, identifies the pre-design data gaps, and describes the sampling design and rationale for the pre-design field sampling plan (FSP). Section 3 contains the FSP, which provides specific guidance for field procedures to be followed by Integral and its subcontractors during the field investigation. Section 4 summarizes the data management procedures. References cited in this report are listed in Section 5.

The following documents are provided as appendices to this SAP:

- **Health and Safety Plan (HSP) Addendum.** This document describes the requirements and procedures that will be implemented to ensure the safety of personnel that carry out the field investigation program (Appendix A). This addendum is provided as a supplement to the HSP presented by Integral (2004b).
- **Standard Operating Procedure (SOP).** This SOP describes the procedures for using a hollow-stem auger (HSA) to collect sediment samples with a split-spoon sampler and a Shelby tube sampler (Appendix B).

- **Quality Assurance Project Plan (QAPP) Addendum.** This document describes the organization, functional activities, and quality assurance and quality control (QA/QC) protocols necessary to achieve the program-specific data quality objectives for sample collection and analysis specified in this SAP (Appendix C). This addendum is provided as a supplement to the QAPP for the Boundary Definition SAP (Integral 2004b).
- **Field Forms.** These documents consist of boring logs, sediment sampling forms, and chain-of-custody forms (Appendix D).

This Pre-Design SAP Addendum has been prepared according to USEPA (1988, 1998, 2002) and Ecology (2003) guidance and is consistent with work being performed for the LDW remedial investigation, as described in the Boundary Definition SAP (Integral 2004b).

2 PRE-DESIGN DATA GAPS

This section summarizes the recommended alternative, the data gaps identified for the pre-design investigation, and the design and rationale for the pre-design FSP.

2.1 SELECTED ALTERNATIVE

Four removal alternatives were presented in the EE/CA (Integral 2006). Alternative 2 was recommended by the City and King County because it is considered to present the most practical and cost-effective balance of contaminant removal and containment that ensures long-term effectiveness, provides the greatest habitat benefits, and minimizes potential long-term maintenance requirements (Integral 2006). EPA selected Alternative 2 in the Action Memorandum for a Non-Time-Critical Removal Action at the Slip 4 Early Action Area (USEPA 2006). Components of Alternative 2 include:

- Targeted removal by dredging of contaminated sediments at the head of the slip in order to remove near-surface material with the highest concentrations of contaminants, while minimizing changes to mudflat habitat at the head of the slip and accommodating outfall flows.
- Removal of piling and debris.
- Excavation of banks to ensure no net loss of aquatic habitat.
- Disposal of excavated and dredged material in a landfill that meets state and federal requirements for disposal of such material.
- Construction of engineered sediment caps over the entire Slip 4 removal area, including engineered slope caps on the affected banks; portions of the cap would be thickened and graded to expand and enhance shallow subtidal and intertidal habitat.
- Acquisition of the landowner’s permitted use of a berthing area (through purchase by the City of Seattle of property in the inner portion of the slip) because implementation of the removal will eliminate the berthing area.
- Implementation of institutional controls.
- Long-term monitoring and reporting.
- Removal of sediment accumulations within the lowest segment of the Georgetown flume, and potential outfall modifications.

To accommodate these actions, a portion of the existing Crowley pier may be removed from within the removal action area. During project design, the City of Seattle and King County will evaluate the most feasible approach to remediate the under-pier area and to implement long-term maintenance of that remedy. The evaluation will include consideration of effectiveness, implementability, cost, and habitat functions.

2.2 DATA GAPS FOR PRE-DESIGN INVESTIGATION

Data needs to be filled in this pre-design investigation include documentation of structures, debris, and outfall locations; additional seep characterization; and additional sediment and soil characterization for removal and cap placement.

Additional data will be generated during the design, but are outside the scope of this investigation. These include:

- Sediment accumulations currently present within the lowest segment of the Georgetown flume (approximately 370 ft of the flume upgradient from the outfall itself) will be assessed. Accumulated sediments that have the potential to recontaminate Slip 4 will be removed either as part of this removal action or as a separate action by the City of Seattle. Modifications or upgrades to the Georgetown flume outfall structure may also be necessary as part of this removal action to ensure proper function of the outfall structure (i.e., free-draining at a low tide), since it is currently at a lower elevation than the sediments immediately adjacent to the outfall. Alternatives include designing the cap to accommodate the existing outfall structure, raising the elevation of the outfall structure, and abandoning the outfall structure. Predesign investigations of the flume are being contracted and implemented separately by the City. The results of these investigations will be presented in the Slip 4 EAA design documents or in a separate design package for the flume.
- Consistent with EPA and USACE guidance (USEPA 1998), caps constructed in Slip 4 will be engineered to withstand erosive forces (e.g., from outfall scour and propeller wash). Existing data such as outfall pipe construction details, hydrographs, vessel characteristics, navigation areas, etc. will be assembled and analyzed during the design phase, and no additional field data are required for this design component.
- During the design, a structural survey of the Zone 4 bulkhead and Crowley's pier will be completed to document pre-construction conditions of these structures. If the decision is made to remove a portion of the Crowley pier, the structural survey will generate the information required for the design of the pier removal.
- Finally, existing bathymetric/topographic data for Slip 4 were collected in September 2004 and include high-resolution survey data for all project areas, including the under-pier areas. These data are sufficient for the design; however, minor shoaling or erosion may occur prior to construction. The design may

specify another pre-construction survey to provide baseline bathymetry to be used for calculating payment volumes for the construction contractor.

2.2.1 Field Conditions Documentation

2.2.1.1 Structures and Debris

Structures in and adjacent to Slip 4 are illustrated in Figure 2-1. The dominant structures in Slip 4 are the Crowley pier and berthing area along the western shoreline, which are currently used for barge loading and unloading (Integral 2006). Portions of the east shoreline (First South Properties) and the bank at the head of the slip are lined with discontinuous segments of timber piles and wood-lagging-supported bulkheads and cinderblock bulkheads. Parts of a derelict wooden loading structure remain on the western shoreline between the Crowley pier and the head of the slip (Integral 2006). There is a considerable amount of concrete debris and partially buried logs and piling near the toe of the banks around the head of the slip. There is also a series of large timber skids at the head of the slip, in the northwest corner. The skids are mostly buried by sediment (Integral 2006). Documentation of current site conditions, including a more thorough tally of site debris, is needed for removal action planning.

The information from this field documentation of visible debris will be used in the design to estimate the amounts and types of embedded debris that may be encountered during the dredging/excavation. The Design Analysis Report will evaluate how the debris should be handled and appropriate performance requirements. This information (and all other relevant information from site investigations to date) will be provided to the construction contractor for its use in planning appropriate construction approaches to meet the performance requirements that will be specified in the design. The specific construction approaches will be documented in the Remedial Action Work Plan, subject to EPA approval.

Geophysical features within the southern portion of the Zone 5 embankment on Boeing property will also be evaluated and documented. This information will be used in developing design details for this transition area.

In addition, the presence or absence of fine-grained deposits in the under-pier riprap area will be assessed to provide information for the under-pier cap design.

2.2.1.2 Emergency Overflow Outfall Location

Recent storm drain surveys have located numerous private storm drains and piped outfalls along the Slip 4 shoreline (SEA 2004). Five public outfalls are on record as discharging to Slip 4 at the head of the slip (Integral 2006):

Former Outfall Name	Current Outfall Name[1]	Outfall Diameter (inches)
Slip 4 SD (117)	King County Airport SD #3/PS44 EOF	60
Slip 4 EOF/SD[2]	North Boeing Field SD	24
I-5 SD	I-5 SD	72
Georgetown flume	Georgetown flume	60
East Marginal Way EOF	East Marginal Way PS EOF	36

Notes:
SD = storm drain.
EOF = emergency sewer overflow.
PS = pump station.
[1] Current outfall names were provided by Schmoyer (2006, pers. comm.).
[2] Overflow from the Slip 4 EOF/SD was rerouted to the Slip 4 SD (117). The current outfall names reflect this change.

All of the public outfalls, except for the East Marginal Way PS EOF, have been located in the field. The EOF will be located and photographed, if possible.

Private outfalls will also be located and photographed for design documentation.

2.2.2 Additional Seep Characterization

Seeps occur in the lower intertidal areas of Slip 4 during low tides. These seeps may include both groundwater discharge from nearby uplands as well as drainage of saturated nearshore fill material (Integral 2006). One of the seeps on the east side of Slip 4 (Seep 10, Figure 2-2) was sampled during the Lower Duwamish Waterway Group (LDWG) survey in 2004 (Windward 2004b).[1]

The sample of seep discharge collected in 2004 was filtered in the laboratory using a 1-µm filter and analyzed for mercury, semivolatile organic compounds (SVOCs), PCBs (as Aroclors), and chlorinated pesticides. The filter size was chosen to remove non-colloidal particles greater than 1 µm that may have been introduced into the seep water by the sampling method. Because the turbidity of the sample from Seep 10 was greater than 5 NTU, only filtered samples were analyzed (except for the VOC sample). The sample for other inorganics was filtered through a 0.45-µm filter to represent dissolved fraction. The volatile organic compound (VOC) sample was not filtered.

[1] Sufficient water could not be collected at Seep 10 using the mini-piezometer method. As a result, seep water was collected by placing a funnel with attached tubing into the flowing seep water channel, and flow was directed into the sample container.

PCB concentrations were not detected above the 0.17-µg/L reporting limit (Windward 2004b). The concentration of one metal, copper (at an estimated concentration of 8.69 *J* µg/L), was greater than the acute and chronic marine water quality criteria (4.8 and 3.1 µg/L, respectively). However, this result was qualified as an estimate because copper was detected in the rinsate blank.[2] In addition, copper concentrations (including reporting limits for nondetects) exceeded the water quality criteria at all 18 seeps sampled in the LDW in this investigation (Integral 2006). All other chemicals in the sample from Seep 10 were undetected or less than water quality criteria (Integral 2006). The seep data support the conclusions of previous groundwater studies that, although Seep 10 is an area of elevated sediment contaminant concentrations, groundwater is not a significant contaminant source to Slip 4 sediments.

Analytical data from other seeps in Slip 4 will be used to assess potential contaminant concentrations in these seeps; these data may be used in cap design. The additional seep samples will be analyzed for PCBs, because they are the primary chemicals of concern in Slip 4 sediments.

2.2.3 Additional Sediment and Soil Characterization

2.2.3.1 Verification of Removal Boundary

The southwestern extent of the removal boundary in Shoreline Zone 5 is based on sample results collected north of the current removal boundary (Integral 2006) and the presence of engineered riprap south of the removal boundary. As requested by EPA, additional data characterizing the intertidal surface sediment on the riprap bank of the Boeing property immediately south of the removal boundary are needed to confirm the boundary location.

2.2.3.2 Removal Area Dredging Evaluation

The general physical characteristics of the sediment proposed for dredging need to be characterized, which will help in assessing sediment behavior during dredging, handling, dewatering, and disposal.

2.2.3.3 Removal Area Sediment and Bank Soil Characterization for Disposal

Planning for the disposal of material to be removed will require additional characterization of sediment and bank soil within the removal boundary. Existing data indicate most or all of the excavated and dredged material will have total PCB concentrations less than 50 mg/kg, making it potentially suitable for placement in a

[2] Sample concentrations between 5 and 10 times the rinsate blank concentration are qualified as estimates (Windward 2004b). The copper concentration at Seep 10 (8.69 *J* µg/L) is 5.4 times the associated rinsate blank concentration (1.61 µg/L) and so is qualified as an estimate ("J").

Resource Conservation and Recovery Act (RCRA) Subtitle D solid waste landfill (Integral 2006). However, additional analyses are needed to determine whether the material will qualify as a Washington State-regulated dangerous waste. Testing to determine the material's dangerous waste status will require bulk analysis and potentially Toxicity Characteristic Leaching Procedure (TCLP) analyses.

In addition, federal regulations under the Toxic Substances Control Act (TSCA) regarding the disposal of remediation waste with PCB concentrations ≥50 mg/kg may apply to sediment in a limited area at the head of the slip in the vicinity of the historical sampling station SL4-6A. Total PCB concentrations of 150 mg/kg were detected in the 0–60 cm sample interval at this location in 1990 (Landau 1990). Additional sediment samples are needed to determine if a definable area exists where PCB concentrations are greater than 50 mg/kg. If so, the design will evaluate if it is practicable for the material excavated from this area to be segregated during construction (Integral 2006).

2.2.3.4 Cap Geotechnical Characterization

Capping of *in situ* surface sediment is planned for the southern portion of the removal area (Integral 2006). Samples for geotechnical analysis will be collected to determine the load-bearing and consolidation properties of the sediment (Table 2-1). These data will provide strength and index properties of the underlying sediment and will be used in the design to define any limitations on cap placement rates or thicknesses, support slope stability evaluations, and predict the expected consolidation of the material beneath the cap.

2.3 SAMPLING DESIGN AND RATIONALE

This section describes the sampling strategy developed to address the identified pre-design data gaps. Additional investigations are needed to characterize overall field conditions, surface and subsurface sediment, seep water, and bank soil. The types of samples required, the rationale, and analyses are listed in Table 2-1. The proposed subsurface core, and bank sample and surface grab sample location coordinates are listed in Table 2-2.

2.3.1 Field Conditions Survey

A survey of current field conditions at the slip will be conducted during a very low tide. In particular, the extent and types of debris visible in the slip will be noted, private outfalls will be photographed, and attempts will be made to locate the East Marginal Way PS EOF. Additionally, the locations of seeps observed during the field survey will be noted to identify the seeps to be sampled.

In the under-pier riprap area, the presence or absence of fine-grained deposits will be assessed to provide information for the under-pier cap design. Three transverse sections from approximately 0 ft mean lower low water (MLLW) to +12 ft MLLW will be visually and photographically documented for presence of fine-grained material in riprap interstices.

Geophysical features within the southern portion of the Zone 5 embankment on Boeing property will be visually evaluate and documented.

In addition, a structural survey of the Zone 4 bulkhead and Crowley's pier will be completed to document pre-construction conditions of these structures. This survey will be accomplished at a later date, during the design process. If the decision is made to remove a portion of the Crowley pier, the structural survey will generate the information required for the design.

2.3.2 Seep Water Sampling

Intertidal seep samples are planned to further quantify any PCB concentrations that may be present in discharges of upland groundwater to the slip. The sediment cap can be designed using existing data from the LDW seep survey, and established procedures in EPA/USACE (USEPA 1998) guidance for evaluating contaminant transport. Based on the results of the LDW seep survey and current knowledge of the surrounding upland areas, EPA and Ecology did not believe that additional seep sampling was necessary for source control determinations related to Slip 4 sediments. However, during development of the EE/CA, the community voiced concerns that additional seep data should be collected (DRCC 2006). Based on the community concern, additional seep samples will be collected. This information will provide additional data that may be used in the sediment cap design.

Seep sampling will consist of the collection of water samples from four to six seeps, the locations of which will be selected based on field observations (see Table 2-1). Seep sampling will be conducted along Zone 2 through 5 (see Figure 2-2), where seeps are identified. The procedures to be used for seep sample collection will generally follow methods used for previous seep sampling (Windward 2004a), discussed in Section 3.3.2 below. Seep samples will be collected at low tide and submitted for laboratory analysis of PCBs as Aroclors and dissolved organic carbon (DOC). Field water quality parameters (temperature, conductivity, turbidity, dissolved oxygen, pH, salinity, and oxidation-reduction potential) will be collected from the seep prior to sampling. Water quality parameters will also be collected in the adjacent surface water at the time of sampling each seep.

2.3.3 Surface Sediment Sampling

Surface sediment data are needed to assess intertidal sediment conditions on the riprap bank of the Boeing property and will be used to verify the location of the removal boundary in that area. Four intertidal locations (SG30, 31, 32, and 33) south of the removal boundary in Shoreline Zone 5 at elevations above 0 ft MLLW will be sampled; the approximate locations are illustrated in Figure 2-2. Analytical parameters for these surface samples will include PCBs as Aroclors and total organic carbon (TOC) (see Table 2-1).

2.3.4 Subsurface Sediment and Soil Sampling

Subsurface sediment and soil data are needed to:

1. Characterize removal area sediment physical properties for dredging evaluation.
2. Characterize removal area sediment and soil for potential disposal under Washington State Dangerous Waste regulations.
3. Characterize removal area sediment near the head of the slip that may require potential disposal under TSCA.
4. Evaluate sediment-bearing capacity and consolidation properties for the cap design.
5. Provide data for slope stability (static and seismic) analyses in design.

The samples that will address these needs are discussed in this section and presented in Table 2-1.

All subsurface soil samples will be characterized according to the Unified Soil Classification System (USCS), as per current annual American Society for Testing and Materials (ASTM) Methods (ASTM 2003). This visual/manual classification will occur in the field per ASTM D2488 and will be recorded on boring logs, except where undisturbed samples for geotechnical characterization are submitted to the laboratory. For those samples, the laboratory will perform the USCS classification following ASTM D2487.

2.3.4.1 Removal Area Characterization

Shelby tube samples will be collected from HSA borings at three locations in the area to be dredged (Stations SC12, SC13, and SC16; see Figure 2-2), which includes the historical sampling location SL4-6A (SC16; Landau 1990), to evaluate sediment physical properties for remedial dredging evaluation and disposal requirements. The cores will extend from the surface to 5 ft below the mudline (bml). Samples from three discrete intervals will be collected from each core using a Shelby tube sampler advanced with a barge-mounted

HSA drilling rig. The samples will be extruded and classified according to the USCS in the field. Samples from each interval will be submitted for analysis of geotechnical parameters, including water content, specific gravity, grain-size distribution, Atterberg limits, and TOC. The target sample intervals are 0–2 ft, 2–4 ft, and 4–5 ft bml; however, the actual intervals will be selected in the field so that each sample represents only one type of sediment. If the sediment is uniform, the target intervals will be used. If there is a change in sediment type (i.e., from plastic silt to sand), the sample intervals will be adjusted.

To determine the disposal requirements for the sediment to be dredged, one composite sample representing the total lengths of the three cores (SC12, SC13, and SC16 combined) will be collected. This sample will be submitted for the following chemical analyses for disposal characterization: PCBs, SVOCs, metals, chlorinated pesticides, extended diesel-range total petroleum hydrocarbons (TPH-Dx), gasoline-range TPH (TPH-G), and TOC. A sample aliquot will be collected for TCLP analysis of SVOCs, metals, and chlorinated pesticides, and will be archived at the laboratory. TCLP analysis will be contingent on the results of dry-weight analysis. TCLP analysis will only need to be performed if the TCLP contaminants in the results from the total analysis are greater than or equal to 20 times the maximum concentration for toxicity characteristic regulatory levels (set forth in Table 1 of 40 CFR 261.24). The "20 times rule" is allowable because of the sample dilution that is a component of the TCLP Method 1311 (Section 1.2 of this method), as is clarified in EPA 540-R-94-005a.

To determine the disposal requirements for the bank sediment to be removed, one composite sample of soil from the surface to a depth of approximately 3–4 ft bgs will be collected from SB21, and one composite sample of soil from similar depths will be collected from SB22 and SB23. The bank borings or test pits will be logged, and soils will be classified by the USCS in the field. The two composite samples will be submitted for SVOCs, metals, chlorinated pesticides, TPH-Dx, TPH-G, TOC, and geotechnical analyses, including water content, specific gravity, grain-size distribution, and Atterberg limits. Sample aliquots collected for TCLP analysis of SVOCs, metals, and chlorinated pesticides will be archived at the laboratory, and analysis will be contingent on the results of dry-weight analysis.

Subsurface sediment cores will be collected to determine if there is a definable and separately manageable area with PCB concentrations requiring TSCA disposal near the historical SL4-6A location. Five HSA cores extending from the surface to 5 ft bml will be collected at the historical location SL4-6A (SC16) and surrounding locations (SC14, SC15, SC17, SC18; see Figure 2-2). The samples will be collected in Shelby tubes, extruded in the field, and classified by USCS. Composite samples representing the full core length will be collected from each core (i.e., five samples) and submitted for PCB analysis.

Archived sediment samples from vibracore SC01 collected in April 2004 will be submitted for analysis of the following geotechnical parameters to determine the dredgeability and handling characteristics of the sediment: USCS classification, water content, TOC, specific gravity, grain-size distribution, and Atterberg limits. A total of three archived samples from this core have been selected, consisting of the 0–2, 2–4, and 4–6 ft sample intervals.

2.3.4.2 Cap Geotechnical Characterization

Samples will be collected to evaluate consolidation of sediments underlying the cap, as well as the bearing capacity and slope stability of the underlying sediments. These data will be used in cap design. An HSA equipped with both a Shelby tube sampler and a split-spoon sampler will be advanced to 20 ft bml (sampling method to be determined based on observed soil conditions). Samples for geotechnical analysis will be collected in Shelby tubes at Stations SC19, SC20, SC21, and SC22 from 0 to 2.5 ft, 2.5 to 5.0 ft, and 5.0 to 7.5 ft bml. The Shelby tubes will be capped in the field and submitted to the lab. Split-spoon samples will be taken from depths of 7.5 ft to the bottom of the boring at intervals of 2.5 ft, logged in the field per USCS (ASTM D2488), and standard penetration test (SPT) blowcounts will be recorded. No chemical or geotechnical analyses of these deeper sample intervals are planned, but deeper samples will be archived for potential additional index testing. Samples will be handled and shipped, as described in Section 3.3.4.

From each boring location, one or two representative subsamples of fine-grained sediment from the Shelby tubes will be analyzed by consolidation testing and unconsolidated, undrained (UU) triaxial shear testing. The actual sample intervals for consolidation/strength testing will be selected by the field coordinator when the samples are extruded at the lab, and will be based on material characteristics. These analyses will be run on an approximate 6-in. interval of sediments.

In addition, from each boring location, one or two representative subsamples from the Shelby tubes will be analyzed for grain-size distribution, USCS classification in the laboratory (ASTM D2487), water content, bulk density, specific gravity, Atterberg limits, and TOC. The above parameters will be analyzed on 1 or 2 samples per boring location even if it is determined that the sediments are not fine-grained. Additionally, if noncohesive sand layers are encountered, direct shear testing of those layers may be conducted.

3 FIELD SAMPLING PLAN

The following sections describe the project organization, anticipated field event schedule, field survey and sampling methods (and other procedures that will be followed during field operations), and the laboratory analyses to be conducted. This information augments the field sampling plan provided in the Boundary Definition SAP (Integral 2004b).

3.1 PROJECT ORGANIZATION

This section presents the organizational structure for sampling and analysis activities associated with the Slip 4 pre-design investigation, including team organization and responsibilities, fieldwork, data management, and laboratory analyses.

3.1.1 Team Organization and Responsibilities

The organization and responsibilities of the investigation team remain as presented in the Boundary Definition SAP (Integral 2004b).

Ms. Karen Keeley, U.S. EPA Region 10, is EPA's Remedial Project Manager for Slip 4. Ms. Keeley is responsible for approving this SAP and any subsequent modifications.

Ms. Ginna Grepo-Grove, U.S. EPA Region 10, is EPA's Quality Assurance Manager for this project. Ms. Grepo-Grove will review and provide final approval of the QAPP Addendum and data quality report.

Ms. Jennie Goldberg is the Project Coordinator and the City of Seattle's Project Manager, responsible for providing contract direction to Integral.

Integral is responsible for implementing the sampling program and preparing the associated reports for U.S. EPA Region 10 on behalf of the City of Seattle and King County.

3.1.2 Integral Personnel

Integral project personnel for the Pre-Design SAP Addendum are identified below.

Position	Personnel
Integral Principal in Charge	Betsy Day
Project Manager	David Schuchardt
Field Coordinator/Safety Officer	Jane Sund or Susan FitzGerald
Project QA Coordinator	Reid Carscadden
Laboratory Coordinator and QA Manager	Maja Tritt
Data Manager	Tom Schulz

The organizational structure of the lead sampling and analysis personnel and analytical laboratory is shown in Figure 1 of the QAPP Addendum (Appendix C). Project roles remain as outlined in the Boundary Definition SAP (Integral 2004b) with modifications reflected in Figure 1 of Appendix C.

3.2 FIELD SAMPLING SCHEDULE

Field work for the pre-design investigations is tentatively scheduled to begin in June 2006 and estimated to be completed in 5 days. Many of the field tasks depend on tide levels and will be scheduled accordingly.

3.3 FIELD SURVEY AND SAMPLING METHODS

The Slip 4 pre-design elements include a field conditions survey, seep water sampling, intertidal surface sediment sampling, subsurface bank soil sampling, and subsurface sediment coring. The methods to be used for the collection of these field data are described in this section. All field documentation, station positioning, sample handling, equipment decontamination, waste disposal, chain-of-custody, and QC procedures will follow those described in the Boundary Definition SAP, except where noted below (Integral 2004b). All field documentation will be recorded on either boring logs or sample collection forms (Appendix D). All sample locations will be located using a Differential Global Positioning System (DGPS), as described in the Boundary Definition SAP (Integral 2004b).

All field activities will be conducted in accordance with the site-specific HSP that is provided in Appendix A.

3.3.1 Field Conditions Documentation

The objectives of the field conditions documentation are to:

- Record visible shoreline and intertidal debris near and at the head of the slip

- Attempt to locate the East Marginal Way PS EOF
- Photograph and document conditions of all public and private outfalls
- Note locations of intertidal seeps
- Visually evaluate and document geophysical features within the southern portion of the Zone 5 embankment on Boeing property
- Document the presence/absence of fine-grained deposits within the riprap in the under-pier area.

The site survey will consist of notes regarding the types, locations, and approximate quantities or areas of intertidal debris, the anticipated location of the East Marginal Way PS EOF, the locations of intertidal seeps, and site photographs. Site photos will include overviews and close-up views of the site conditions noted, as appropriate. The coordinates of the EOF outfall will be recorded. In the under-pier area, three transverse sections from approximately 0 ft MLLW to +12 ft MLLW will be visually and photographically documented for presence of fine-grained material in riprap interstices.

A structural survey of the pier and Zone 4 bulkhead will be completed at a later date.

3.3.2 Seep Water Sampling

Four to six seep samples will be collected at locations identified in the field conditions survey. Seeps with the highest visually apparent flow rates will be targeted for sampling. Insufficient flow from some seeps may limit the total number of seep samples that can be collected.

Seep water sampling will be conducted generally following the methods of Windward (2004a). Windward's QAPP identified stainless-steel PushPoint mini-piezometers developed and sold by MHE Products as the preferred sampling method, and also identified three alternative sampling methods if the piezometers yielded high turbidity or insufficient flow:

1. Placement of an appropriate sampling container directly under an actively flowing seep from a moderate- to steep-sloping embankment.
2. Placement of a glass funnel, Teflon® sheeting, and/or Teflon® tubing, as appropriate, below seeps where water cannot be collected directly under the flow. Pre-assigned, pre-cleaned funnels, sheeting, and tubing will be used at each sampling location to avoid contamination from other locations. Sampling equipment will be pre-cleaned by Frontier, as described in EPA Method 1669 (USEPA 1996).

3. Excavating a pit in the sediment, lining the pit with a stainless-steel bowl, allowing it to fill with seep water, and dipping a pre-cleaned glass beaker in the bowl to collect the seep water.

The actual field sampling results from the Windward (2004a) sampling effort yielded insufficient flow at the seep location in Slip 4 (Seep 10), and the actual sampling method previously used in Slip 4 was the glass funnel/tubing alternative method described in the second bullet above.

For this investigation, the piezometer method is not proposed based on the previous experience in Slip 4. The preferred method for this investigation is the third alternative method described above. This method is preferred over the funnel and tube method because it allows continuous readings of conventional water quality parameters prior to and during sampling, provides a flow-through cell for accurate measurement of conventional water quality parameters, and minimizes sample disturbance such as changes in oxidation-reduction potential.

A small depression will be dug into the sediment immediately downgradient of the seep so that the seep flow will pool in the depression; alternatively, the flow may be directed into a decontaminated container inserted into the depression. Measurements of water quality parameters (temperature, conductivity, turbidity, dissolved oxygen, pH, salinity, and oxidation-reduction potential) will be collected from the pool of seep discharge; the parameter readings will be allowed to equilibrate prior to recording. Measurements will be recorded on the water sample collection form (Appendix D). The seep samples will be collected from the depression using a pre-cleaned glass beaker or a peristaltic pump with attached dedicated disposable tubing. Care will be taken to minimize the entrainment of sediment into the collected seep water. Samples will be collected at low tide and at a period when minimum salinity is observed in the discharge, to obtain a sample that is most representative of groundwater discharge. Samples will be filtered in the field using a 1-µm glass fiber filter. Only filtered samples will be collected since any sediment entrained by the sampling method (even at low turbidity readings) could result in a high biased analytical result. The filtered samples will be submitted for PCB and DOC analysis.

Measurements of water quality parameters (temperature, conductivity, turbidity, dissolved oxygen, pH, salinity, and oxidation-reduction potential) will also be collected from adjacent surface water at the time of sample collection at each seep.

3.3.3 Sediment and Soil Sampling

The equipment and procedures that will be used to collect surface and subsurface sediment samples are discussed in the following sections. Field documentation of sample collection will be recorded on either boring logs or sediment/soil collection forms

(Appendix D). Photographs will be taken of each sampling interval in the subsurface samples as well as from the individual sampling pits.

3.3.3.1 Surface Sediment Sampling

The surface sediment samples (0–10 cm) will be collected during low tide from intertidal Stations SG30 through SG33 using stainless-steel bowls and spoons. The surface sediment will be submitted for PCB and TOC analyses.

3.3.3.2 Subsurface Sediment and Soil Sampling

All subsurface soil samples will be characterized according to the USCS. The Visual Manual Method (ASTM D2488) will be used in the field and will be recorded on boring logs, except where undisturbed samples for geotechnical characterization are submitted to the laboratory. For those samples, the laboratory will perform the USCS classification following ASTM D2487. Samples will be handled and shipped, as described in Section 3.3.4.

Samples for Removal Area Characterization

Subsurface sediment cores for the dredge area characterization will be collected using Shelby tube samplers advanced through HSA borings from a barge-mounted drill rig. The proposed borehole locations are shown in Figure 2-2. Samples will be collected from 0 to 5 ft bml at each location, according to the SOP for HSA/Shelby tube sampling (SOP 6; Appendix B). The core intervals will be sampled discretely or composited per the requirements at each station. The cores will be subsampled according to two to three different schemes, as discussed below.

Sediment cores from seven locations will be used to characterize sediment in the area to be dredged. The cores will be subsampled into three sample intervals, as described in Section 2. These discrete samples will be analyzed for geotechnical parameters as follows:

- Nine subsamples from SC12, SC13, and SC16 will be analyzed for grain-size distribution, water content, specific gravity, and Atterberg limits.

Six samples will be submitted for chemical analysis to evaluate disposal requirements, as follows:

- One composite sample representing the entire recovered lengths of cores from SC12, SC13, and SC16 will be submitted for chemical analysis to evaluate whether the material will require disposal as a Washington State Dangerous Waste. Analysis of this sample will include PCBs, chlorinated pesticides, SVOCs, metals, TPH-Dx, TPH-G, TOC, and TCLP analysis for SVOCs, chlorinated pesticides, and metals.

- Five samples, each representing the entire recovered lengths of one of five discrete cores from Stations SC14 through SC18 near the head of the slip, will be submitted for PCB analysis to determine if segregation of an area potentially requiring disposal under TSCA regulations is practicable.

Bank material in the removal areas will be sampled and submitted for chemical analysis to evaluate whether the material will require disposal as a Washington State Dangerous Waste. These bank samples will be collected from hand augers and/or hand-dug test pits advanced to approximately 3–4 ft bgs:

- One composite sample will be collected from SB21, representing the approximate 0–4 ft depth interval to be removed.
- One composite sample will be collected of material from SB22 and SB23, representing the approximate 0–4 ft depth interval to be removed.

Chemical analysis of these bank samples will include PCBs, chlorinated pesticides, SVOCs, metals, TPH-Dx, TPH-G, TOC, and TCLP analysis for SVOCs, chlorinated pesticides, and metals. Geotechnical analyses for these samples will include grain-size distribution, water content, Atterberg limits, and TOC. Due to the widespread occurrence of riprap and/or buried debris, it is anticipated that hand-dug test pits (advanced using a shovel) will likely be necessary, and locations may need to be adjusted in the field. The cores or test pits will be logged and classified following ASTM D2488. The test pits will be logged from the excavated test pit sidewall.

Cap Geotechnical Characterization

Subsurface sediment cores for capping geotechnical characterization will be collected using Shelby tubes and split-spoon samplers advanced through HSAs, following the SOP for Shelby Tube Sampling (SOP 6; Appendix B). The samples will consist of undisturbed Shelby tubes collected from the intervals described in Section 2, at Stations SC19, SC20, SC21, and SC22. The undisturbed Shelby tubes will be sealed and submitted to the analytical lab, and up to two sample intervals from each boring will be analyzed for consolidation testing. The sample intervals for lab testing will be determined by the Integral Field Coordinator at the lab. Fine-grained sediment subsamples will be analyzed by consolidation testing, and UU triaxial shear, grain-size distribution, water content, bulk density, specific gravity, Atterberg limits, and TOC. The lab will also record the USCS classification of the undisturbed samples.

The deeper sample intervals from these borings (to 20 ft bml) will be continuously sampled using a split-spoon sampler, logged in the field per USCS, and SPT blowcounts will be recorded.

Archived Samples

Three archived samples from SC01, collected in 2004, will be analyzed for grain-size distribution, USCS classification, water content, and Atterberg limits.

3.3.4 Sample Handling and Transport

Sample jars, coolers, and packaging material will be supplied by the analytical laboratory. Details on the numbers and type of sample containers are provided in the QAPP Addendum (Appendix C). Seep water samples, bank subsurface soil samples, surface sediment samples, and disturbed subsurface sediment samples will be handled and transported in accordance with the procedures in the Boundary Definition SAP (Integral 2004b).

Undisturbed Shelby tube samples will be handled following ASTM D3213 *Standard Practice for Handling, Storing, and Preparing Soft Undisturbed Marine Soil*. This standard covers the methods for project/cruise reporting, and handling, transporting, and storing soft cohesive undisturbed marine soil. The tube ends of the undisturbed Shelby tube samples will be sealed in the field, as per SOP 6 (see Appendix B) to prevent leakage of pore water. The tubes will be maintained in a vertical orientation and transported to the laboratory with minimal disturbance.

3.3.5 Equipment Decontamination

The handcores will be rinsed with site water and washed with Liqui-nox™ detergent prior to use and between sampling stations. Decontamination of stainless-steel bowls and spoons will also be performed before using sampling equipment at each station, using the following process:

- Rinse with site water.
- Wash with Liqui-nox™.
- Double rinse with distilled water.
- Rinse with deionized water.
- Rinse with methanol.
- Final rinse with deionized water.

If a residual petroleum sheen remains on the sampling equipment or is difficult to remove using the standard decontaminations procedures above, a final hexane rinse may be added.

Sample equipment will be kept wrapped in aluminum foil until time for use. To minimize sample cross-contamination, disposable gloves will be replaced between stations.

3.3.6 Investigation-Derived Waste

Investigation-derived waste will be managed as described in the Boundary Definition SAP (Integral 2004b).

3.4 FIELD QUALITY CONTROL SAMPLES

QC requirements will be instituted during field sampling, laboratory analysis, and data management to ensure that the data quality objectives from Integral (2004b) are met. Detailed information on QA/QC procedures, limits, and reporting are described in detail in the QAPP (Integral 2004b) and QAPP Addendum (Appendix C).

Field QC samples will be collected as specified in the Boundary Definition SAP (Integral 2004b), with the exception that field replicates will only be collected during seep sampling. Field QC samples will include field split samples (for surface sediment sampling) and equipment rinsate blanks (for seep sampling and surface sediment sampling). The types and numbers of QC samples that will be collected are listed in Table 4 of the QAPP Addendum (Appendix C).

3.5 LABORATORY ANALYSES

Laboratory analyses will be performed according to the Boundary Definition QAPP (Integral 2004b) and the QAPP Addendum (Appendix C).

4 DATA MANAGEMENT AND REPORTING

During field, laboratory, and data evaluation operations, effective data management is the key to providing consistent, accurate, and defensible data and data products. The management and reporting of field and laboratory data will generally follow the procedures outlined by Integral (2004b). Changes or additions to those procedures based on the specific requirements of this FSP are discussed in the following sections.

4.1 SAMPLE NUMBERING

According to Integral (2004b), all samples will be assigned a unique identification code based on a sample designation scheme designed to suit the needs of the field personnel, data management, and data users. Sample identifiers will consist of two components separated by dashes. The first component is SL4 to identify the data as originating in Slip 4. The second part will contain the following abbreviations for the sample type followed by the sample number:

SB = subsurface bank soil composite sample
CC = subsurface sediment core composite sample
SC = subsurface core sample
SG = surface grab sample
SP = seep water sample.

All station IDs will be numbered sequentially. Surface and subsurface stations will continue the numbering scheme begun during the 2004 sampling (Integral 2004a). Composite core samples and seep samples will each be numbered sequentially starting with 01.

Subsurface core samples will also have a letter that is placed after the sample number to designate the sample horizon in the core. "A" will be used to indicate the top interval (i.e., 0- to 2-ft horizon). All subsequent (deeper) sample intervals will be indicated in alphabetical order ("B", 2–4 ft; "C", 4–5 ft). Core samples collected from the full length of the core will be indicated by "X".

Seep water samples and composite core samples will be numbered sequentially.

Some examples of sample labels include:

- **SL4-SB02:** Second composite subsurface bank soil sample; the stations comprising this composite will be noted in the field log book.

- **SL4-CC01:** First composite sediment core sample; the core stations comprising this composite will be noted in the field log book.
- **SL4-SC14C:** Core sample from the 4- to 5-ft horizon at Station 14.
- **SL4-SC15X:** Sample representing the full length of the core collected at Station 15.
- **SL4-SG32:** Surface grab sample from intertidal Station 32.
- **SL4-SP01:** First seep water sample station.

4.2 LABORATORY DATA

Laboratory data reporting procedures will follow those of the Boundary Definition SAP (Integral 2004b).

4.3 DATA MANAGEMENT

Data management procedures will follow those of the Boundary Definition SAP. Integral will continue to use the Environmental Quality Information System (EQuIS) in conjunction with the ArcView 9 geographic information system (GIS) tools to manage, summarize, and report the generated data. Pre-design data will be submitted electronically to EPA in the SEDQUAL format.

4.4 DATA REVIEW AND REPORTING SCHEDULE

Data validation procedures will follow those called for in the Boundary Definition SAP (Integral 2004b). The results of this pre-design investigation sampling will be presented in a Pre-Design Sampling Data Report that will be an appendix to the 60% Design Documents for the Slip 4 Early Action, currently scheduled for fall 2006. Information to be included in the Data Report will include but is not limited to:

- Field methods and any deviations from the SAP
- Field change requests
- Actual sample locations
- Laboratory analysis results
- Data validation reports
- Core logs
- Sample description forms
- Photodocumentation
- Description of geophysical features on Zone 5 embankment
- Location of the East Marginal Way PS EOF outfall

- Summary of under-pier sediment accumulations in riprap interstices
- Engineer's estimate of debris types and quantities.

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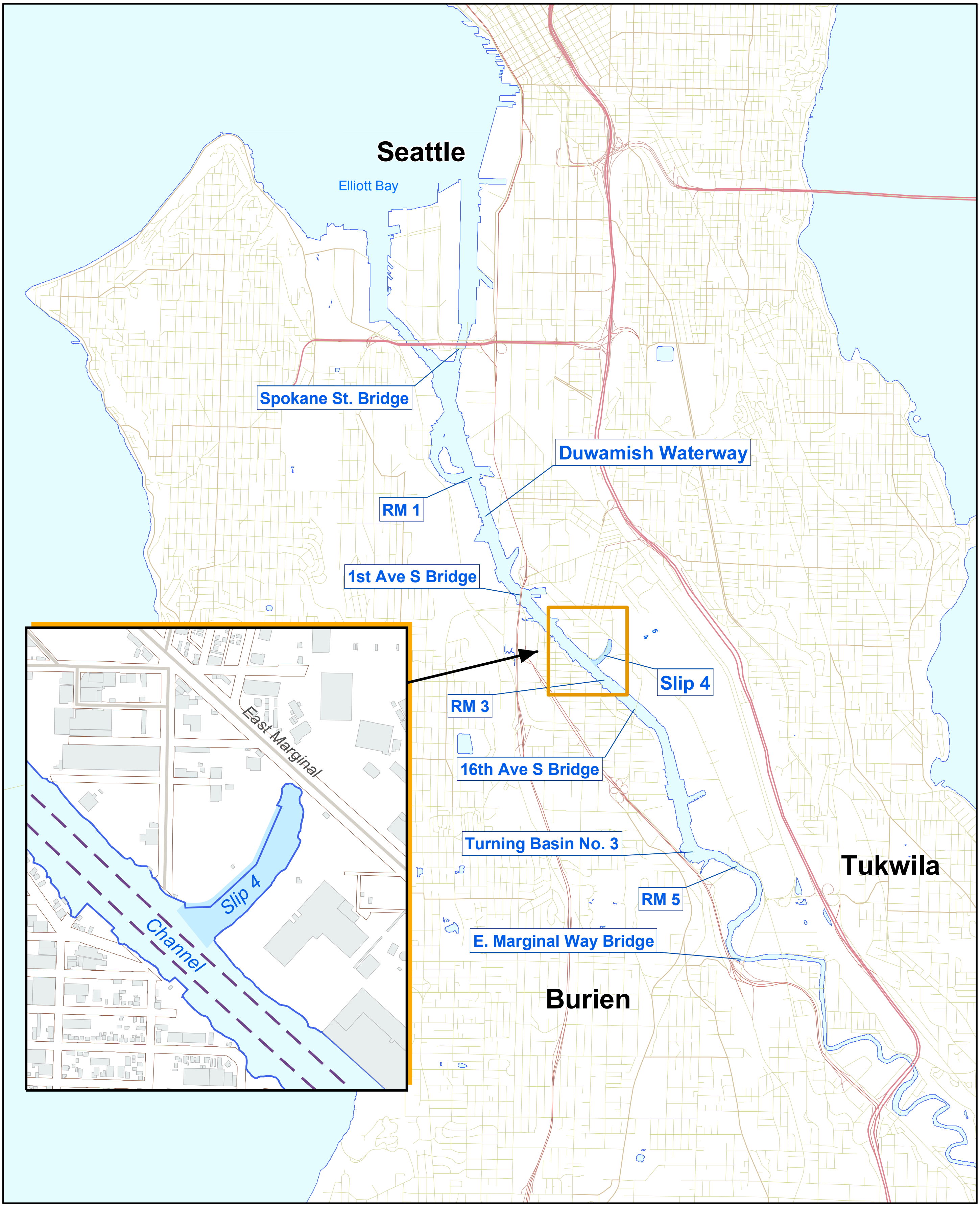
FIGURES



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integral consulting inc.

Map Feature Sources: King County GIS, Seattle Public Utilities, USACE, Ecology, and others.

Figure 1-1.
Site Location Map
Slip 4 Pre-design SAP

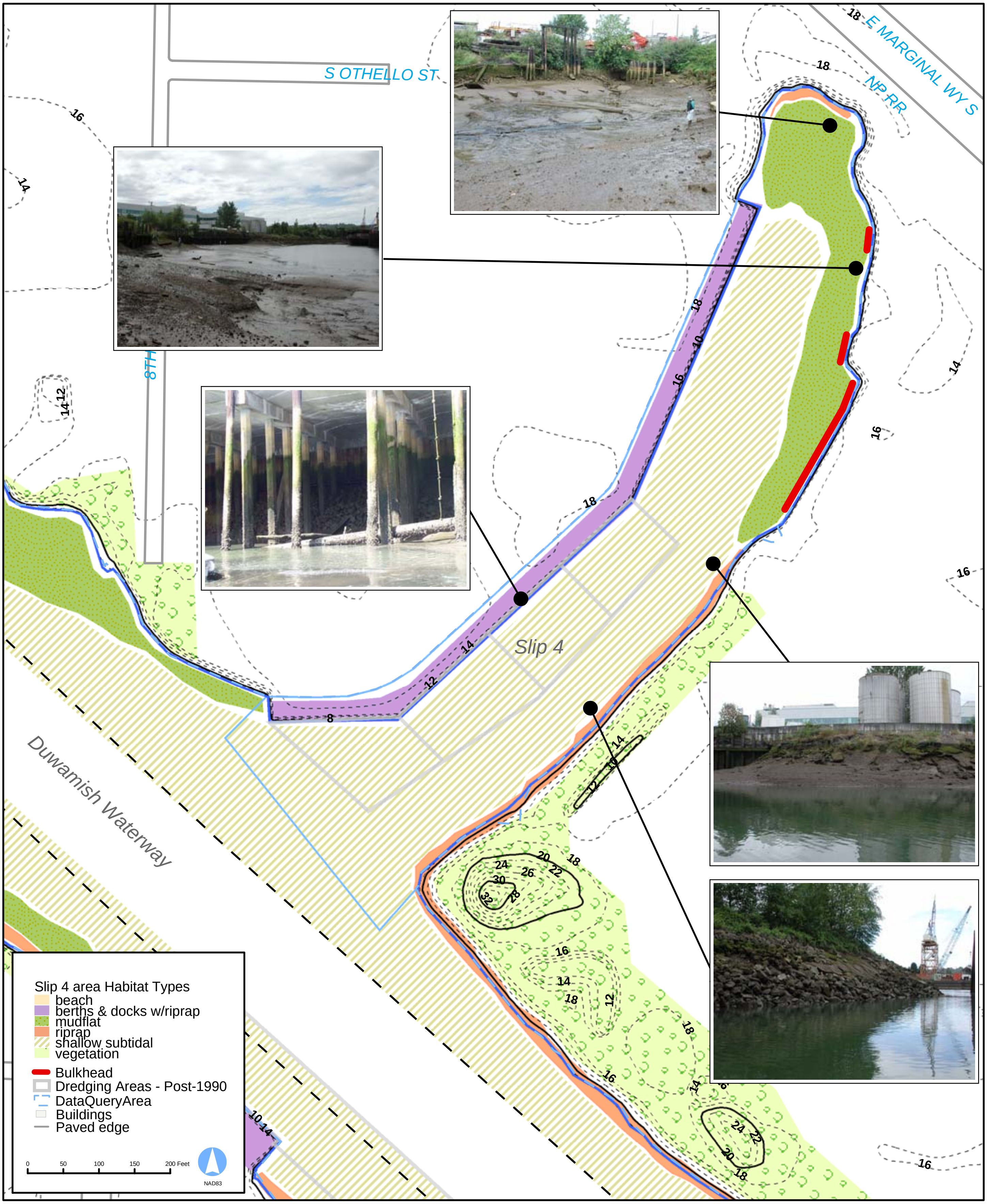

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Figure 2-1.
Site Features
Slip 4 Pre-design SAP

Map Feature Sources: King County GIS, Seattle Public Utilities, USACE, Ecology, and others.

Map Document: (FG-Cross Sections.dwg) - Layout: Proposed Sampling Locations
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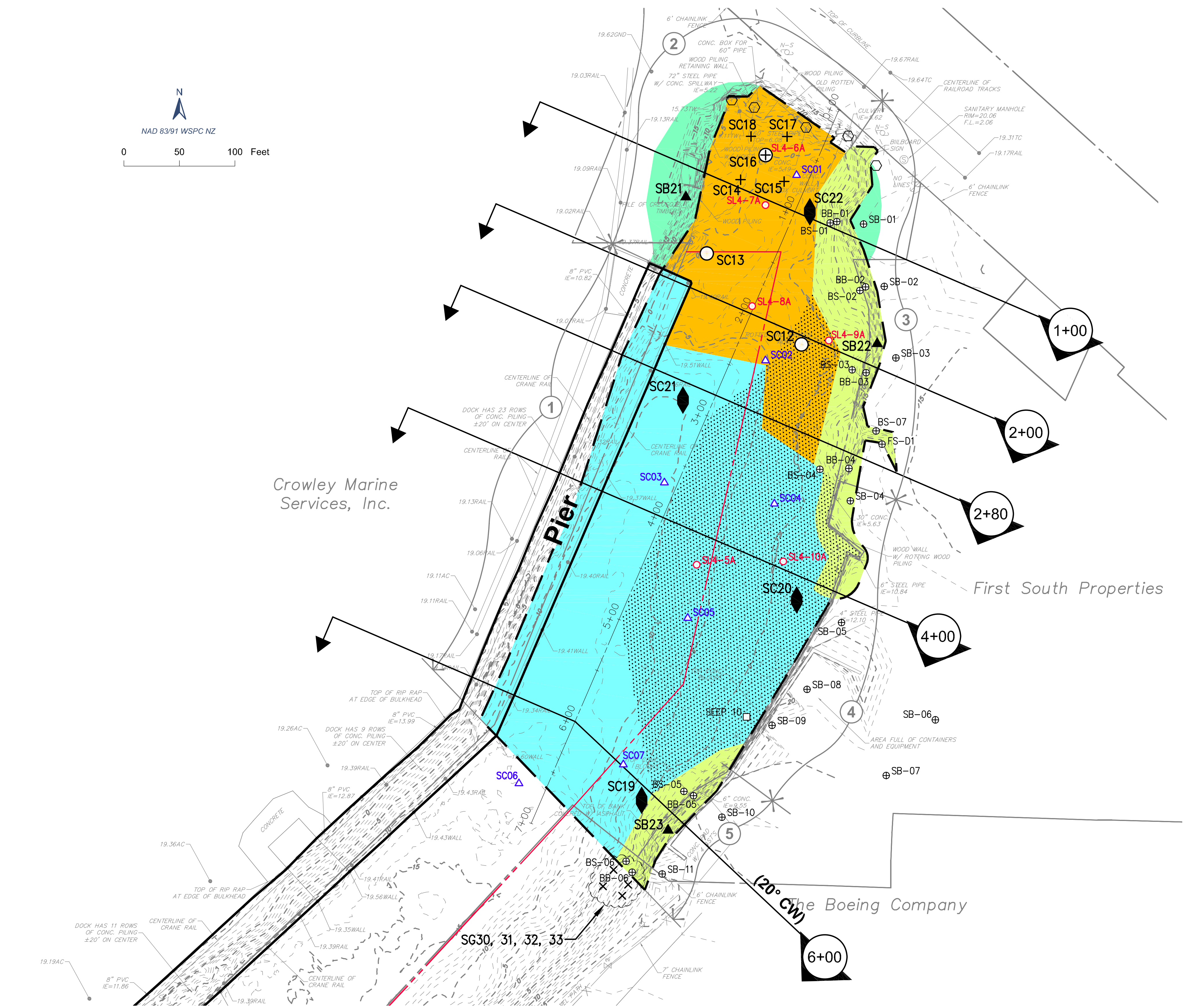

LEGEND

- MAJOR OUTFALL
- POWER POLE
- SANITARY MANHOLE
- LUMINARE
- IRRIGATION CONTROL VALVE
- GUY WIRE
- 19.41WALL SPOT ELEVATION
- 5-FOOT CONTOUR INTERVAL
- 1-FOOT CONTOUR INTERVAL
- FINAL REMOVAL BOUNDARY
- APPROXIMATE PROPERTY LINE
- APPROXIMATE HISTORICAL (1981) DREDGE LIMITS
- 1+00 PROJECT BASELINE
- 4 SHORELINE ZONE
- SEEP SAMPLE LOCATION (2004)
- SURFACE/SUBSURFACE SAMPLE LOCATION – ECOLOGY (2005)
- SUBSURFACE SAMPLE LOCATION – INTEGRAL (2004a)
- SUBSURFACE SAMPLE LOCATION – LANDAU (1990)
- DREDGE 3–6 FEET. CAP TO GRADE WITH EROSION PROTECTION: EROSION PROTECTION REQUIREMENTS WILL VARY BY LOCATION, AS DETERMINED IN DESIGN
- SLOPE CAP
- SAND/GRAVEL CAP
- HABITAT CREATION: FILL REMOVAL AND SLOPE COVER / SLOPE CAP
- HABITAT ENHANCEMENT: CAP THICKENED TO OPTIMIZE INTERTIDAL HABITAT

PROPOSED SAMPLING LOCATIONS

- CAP GEOTECHNICAL EVALUATION SEDIMENT STATION
- REMOVAL AREA EVALUATION SEDIMENT STATION
- REMOVAL AREA EVALUATION BANK SOIL STATION
- TSCA DISPOSAL EVALUATION SEDIMENT STATION
- REMOVAL BOUNDARY VERIFICATION SEDIMENT STATION
- SEEP SAMPLING STATION (TO BE DETERMINED)

NOTES

1. HORIZONTAL DATUM: WASHINGTON STATE PLANE COORDINATE SYSTEM, NORTH ZONE (NAD-83/91), U.S. FEET.
2. CONTOURS ARE SHOWN IN FEET AT AN INTERVAL OF 1 FOOT AND INDICATE ELEVATIONS IN REFERENCE TO MEAN LOWER LOW WATER (MLLW). THE BENCH MARK USED IS "DEA 2005" MLLW ELEVATION 16.17'.
3. TOPOGRAPHIC & HYDROGRAPHIC BASE INFORMATION PROVIDED BY MINISTER-GLAESER SURVEYING INC, 2200 E. EVERGREEN BLVD., VANCOUVER, WA 98661; MGS JOB#: 04-368; MGS DRAWING NAME: 0436BT1.DWG. DATA COLLECTED: OCTOBER 5, 2004.
4. 1981 DREDGE LIMITS FROM MARINE POWER & EQUIPMENT DRAWINGS 071-0YB-2-006580 SHEET 2 OF 4, AND 533-YD5-42CP SHEET 1 OF 10.
5. PROPERTY BOUNDARIES FROM SEATTLE PUBLIC UTILITIES GIS.

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Figure 2-2
Proposed Sampling Locations
Slip 4 Pre-Design SAP

TABLES

Table 2-1. Slip 4 Data Needs for Pre-Design Investigations.

Purpose	Matrix	Sample Type	Sampling Frequency	Stations	Chemical Analyses: Analytes	Chemical Analyses: # Samples	Geotechnical Analyses: Laboratory	Geotechnical Analyses: Field[4]	Geotechnical Analyses: # Samples	Notes
Field Conditions Documentation	--	--	--	--	--	--	--	--	--	Debris tally, photodocument, locate EOF, assess under-pier sediment presence, document Zone 5 characteristics. Structural survey of pier and Zone 4 bulkhead (at later date)
Seep Water Sampling (Bank)	Water	Intertidal seep grab[1]	Estimated 4–6 locations, field-determined	SP01 through SP06	PCBs, DOC	4-6	--	--	NA	Filtered samples. Collect at low tide per LDW procedures. Field WQ parameters measured prior to sampling.[1]
Intertidal Surface Sediments										
Verify Intertidal Boundary at Boeing Riprap	Sediment	Intertidal surface grab (0-10 cm from spoon/bowl)	4 locations south of boundary, above 0 ft MLLW	SG30, SG31, SG32, SG33	PCBs, TOC	4	--	--	0	Requested by EPA.
Intertidal and Subtidal Subsurface Sediments										
Sediment Disposal Characterization - TSCA Remediation Waste	Sediment	Intertidal HSA/Shelby tubes, 5 ft deep	5 locations near SL4-6A, one full-depth composite sample per core	SC14, SC15, SC16, SC17, SC18	PCBs	5	--	USCS classification	0[3]	To assess need for segregation of TSCA material >50 mg/kg PCB.
Sediment Disposal Characterization - Washington State Dangeous Waste; Dredgeability and Handling	Sediment	Intertidal HSA/Shelby tubes, 5 ft deep	3 locations in dredge area, including one at SL4-6A. Index properties on individual core segments. Disposal characterization on one composited sample of all three 5-ft cores.	SC12, SC13, SC16	On Composite: SVOCs, inorganics, chlorinated pesticides, PCBs, TOC, TPH-G, TPH-Dx, TCLP (SVOCs, inorganics, pesticides) [6]	1	On individual sample intervals:[2] water content, specific gravity, grain size, Atterberg limits, TOC	USCS classification	9	
Dredgeability and Handling	Sediment	Archived cores	Archived sediment sample SC-01 @0–2ft, 2–4ft, 4–6 ft.	SC01 (archived)	--	--	USCS classification,[5] water content, specific gravity, grain size, Atterberg limits, TOC.	--	3	
Cap Design - Geotechnical Characterization of Underlying Sediments	Sediment	HSA to 20 ft bml 0-2.5 ft, 2.5-5 ft, 5-7.5 ft Shelby tubes. Split spoons to 20 ft.	4 locations in cap area. From each location, analyze one or two representative 6-in. intervals of fine-grained material for consolidation and strength. Analyze one or two additional intervals for index properties. Sampling intervals to be determined in field based on stratigraphy of the sample.	SC19, SC20, SC21, SC22	--	--	On Shelby tubes: Consolidation and UU Triaxial Shear (only fine-grained materials will be analyzed for these parameters). For the following analyses, representative subsamples will be analyzed regardless of material type: USCS classification,[5] water content, bulk density, specific gravity, grain size, Atterberg limits, TOC	On Split Spoons: USCS classification	8	Borings to 20 ft bml, with both SPT and Shelby sampling. Engineer to direct SPT/Shelby sampling. Submit capped Shelby tubes to lab for subsampling. Archive representative split spoon samples. Up to 2 consolidation and triaxial samples may be submitted per boring, on silt or clay units.

Table 2-1. Slip 4 Data Needs for Pre-Design Investigations.

Purpose	Matrix	Sample Type	Sampling Frequency	Stations	Chemical Analyses: Analytes	Chemical Analyses: # Samples	Geotechnical Analyses: Laboratory	Geotechnical Analyses: Field[4]	Geotechnical Analyses: # Samples	Notes
Bank Subsurface Soils										
Zone 2 Bank Excavation/Disposal Characterization	Bank soils	Composite soil sample from hand auger boring or hand-dug test pit	One composite sample from a boring (to 3–4' bgs) in Zone 2	SB21	SVOCs, inorganics, chlorinated pesticides, PCBs, TOC, TPH-G, TPH-Dx, TCLP (SVOCs, inorganics, pesticides) [6]	1	Water content, specific gravity, grain size, Atterberg limits	USCS classification	1	
Zone 3, 4, 5 Bank Excavation/ Disposal Characterization	Bank soils	Composite soil sample from hand auger borings or hand-dug test pits	One composite sample from borings (to 3–4' bgs) in Zone 3, 4, and 5	SB22, SB23	SVOCs, inorganics, chlorinated pesticides, PCBs, TOC, TPH-G, TPH-Dx, TCLP (SVOCs, inorganics, pesticides) [6]	1	Water content, specific gravity, grain size, Atterberg limits	USCS classification	1	

Notes:

surface

[1] Field water quality parameters will be measured before sampling at each seep location and in adjacent surface water. Parameters include: temperature, conductivity, turbidity, dissolved oxygen, pH, salinity, and oxidation-reduction potential.

[2] Sample target intervals will be from 0–2 ft below mudline (bml), 2–4 ft bml, and 4–5 ft bml.

[3] Geotechnical analyses on samples from SC16 are included under "Sediment disposal characterization - Washington State Dangerous Waste."

[4] USCS classification will be conducted in the field following ASTM D2488, Visual Manual Procedure.

[5] USCS classification will be conducted by the laboratory following ASTM D2487.

[6] TCLP aliquots to be archived for potential future analysis.

-- - not applicable

Table 2-2. Slip 4 Proposed Sample Locations for Pre-Design Investigations.

Station ID	Northing	Easting
SC12	199278.5071	1273514.482
SC13	199360.4344	1273429.089
SC14	199426.8725	1273459.595
SC15	199425.2542	1273498.824
SC16	199449.0406	1273482.094
SC17	199465.7131	1273501.524
SC18	199465.893	1273468.952
SC19	198867.8836	1273370.448
SC20	199048.3314	1273510.154
SC21	199228.3014	1273407.71
SC22	199397.8931	1273521.878
SB21	199411.2452	1273410.305
SB22	199279.1657	1273582.561
SB23	198840.7995	1273394.217
SG30	198805.1522	1273345.121
SG31	198791.841	1273358.284
SG32	198781.8575	1273352.892
SG33	198790.2563	1273335.606

Notes:
Horizontal Datum: Washington State Plane Coordinate System, North Zone (NAD 83/91), U.S. feet.